UNIT I

- Energy use-Past & Present
- Static energy use
- Turbine generators in power plants
- Making a generator (induction coil)
- Making a turbine (pinwheel)
- Making electricity with a turbine engine

What is Electricity?

What is Electricity?

1.1 Energy Use – Past and Present

The Good Old Days or Today?

Some people call the past the “Good Old Days.” In reality, most people would not want to get rid of the machines and conveniences that make life comfortable today and return to the days when work was done by animal and human muscle power. The standard of living is much higher today than earlier in this century.

Much of this change is due to the use of energy consuming devices. Because of our reliance on these things, we consume a lot of energy each day.

Electricity is the energy form that we can easily understand from our daily activities. You will compare how you and your family use electricity today to how families used electricity in the past.

Procedures

1. Have students interview their grandparents, a friend’s grandparents or a senior citizen using the interview sheet, “Energy Encounters.”

2. Read the story, “The Good Old Days,” describing what it was like to live on a farm in the 1930’s. *Read the story with the lights off.*

3. In cooperative groups, brainstorm the idea of what life would be like without electricity. Each group should list 5 to 10 ways life would be different. Examples could be given from the “Household Energy” interview or from the story “The Good Old Days.”

Discussion

1. Have groups share and discuss their ideas. Use a graphic organizer or the board to combine ideas.

2. Develop a statement as to why it would be important to learn more about electricity, how it is produced and how we use it.

What is Electricity?

1.1 Energy Use – Past and Present

Energy Encounter Interview

Methods Used Duties/Activities	Methods Before Electricity	Methods After Electricity
Cooking Food		Electric Range
Heating Water		Water Heater
Storing Food		Refrigerator/Freezer
Washing Clothes		Electric Clothes Washer
Drying Clothes		Electric Clothes Dryer
Ironing Clothes		Electric Iron
Cleaning House		Vacuum Cleaner
Hair Drying		Electric Hair Dryer
Heating		Electric Heating System
Cooling		Air Conditioner/Electric Fan
Entertainment		Television, Radio, Stereo, Computers, DVD. VCR
Hair Curling/Styling		Electric Curler/Curling Iron
Lighting		Electric Light Bulb
Getting Water		Running Water/Electric Pump
Brushing Teeth		Electric Tooth Brush
Carving Turkey		Electric Carving Knife
Popping Popcorn		Microwave Popcorn
Garbage Disposal		Electric Grinder in Sink

What is Electricity?

1.1 Energy Use – Past and Present

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The Good Old Days – Life on the Farm in 1930's

It is April 1937. Roy, a nine-year-old boy, and his eleven-year-old sister, Margie, live on a farm; most of the families in the Hagerstown Valley do. The day begins at 4:30 a.m. when the wind-up, Big Ben alarm clock can be heard all over the house. Mother is the first one in the cold kitchen, where she lights the fire in the wood stove and gets breakfast started. Roy and Margie get dressed and go to the barnyard to do their chores.

They do the milking first. Roy carries the milk buckets to the root cellar where it is cool; they do not have a refrigerator. He then feeds the cow, the mule and the pigs. Margie helps Roy with the milk, then feeds the chickens, collects the eggs and takes some milk from the root cellar for breakfast. Father checks the garden to see if the soil is dry enough to plow. He then goes to the shed and gets the harness and yoke ready to hitch the plow to the mule, Sadie. Plowing is Sadie's and Father's job; tractors are rare in this part of the country.

Mother calls them to breakfast and they hurry in to sit down to a meal of sugar-cured ham, eggs, just-baked biscuits and homemade jam. After breakfast, Roy and Margie draw the water from the well needed for the day's cooking and washing. Then they walk two miles to their one-room

schoolhouse, carrying their books and lunch pails. There is only one teacher; she not only teaches all the subjects and all the students, but she is responsible for maintaining the school. She has arrived early to light a fire in the school's wood stove. The April morning is chilly and the warmth from the stove will feel good.

While the children are at school, Father and Sadie plow the rest of the garden. The garden's tomatoes, beans, corn and other vegetables make up most of the family's diet for the year. As he plows, Father hopes the weather this year will produce a bountiful harvest. Last year's garden supplied the family with enough corn meal and canned and dried vegetables to make it through the winter; there was even enough to sell.

Mother builds a fire under the big black pot filled with water to wash the clothes. Some she scrubs on a wash board, then hangs them on a line to dry. She puts a big pot of pinto beans on the wood stove to cook all day. Later, when the clothes are dry, she irons them with a flat iron that she heats up over the fire and reheats after every few garments.

After they walk home from school, Roy and Margie work on their lessons. Then they play outside for a little while and return to the barnyard to do their evening chores. The cow must be milked again and the animals must be fed and tended. For supper, Mother serves pinto beans, some fried potatoes and a large pan of cornbread. The family is thankful the garden has supplied enough vegetables for the year.

When they finish supper, Margie washes the dishes in a pan filled with water heated on the stove and Mother dries and puts away the dishes. Roy and Father chop the wood and fill the wood box for the next day's use. When the chores are finished, Father reads a story by the light of a kerosene lamp. Mother sits down at the piano and they all sing some songs together before retiring. The bedrooms are chilly so they snuggle in their beds under quilts Grandma made.

On Saturday night, Roy and Maggie look forward to going to their cousin's home where the family gets together to listen to a program on the radio. Their cousins live much closer to town and have electricity. When it is time to go home, they will climb back into the wagon hitched to Sadie. Some of their relatives have cars or trucks. Roy and Margie hope Father will soon have enough money to buy one. He says the Great Depression is over and times are getting better, so maybe they will be able to buy some things the family does without.

Roy and Margie look forward to summer vacation. School will end in May. There will be much to do to care for the garden and the animals and to harvest and preserve the vegetables, but there will be time for fishing in the stream, swimming in the swimming hole and picking berries.

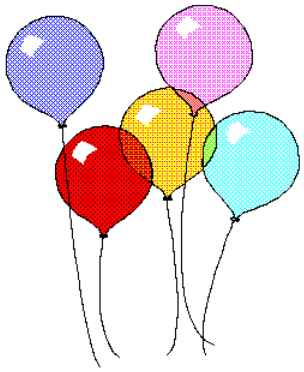
Soon it will be September. Most of the crops will be harvested and Father will have the money he makes from selling what the family will not need. It will be time to buy everyone a new pair of shoes. Roy and Father will get new overalls. Mother and Margie will pick out some material for making new dresses. There will be much work to do to prepare for another winter. There is always work to do on the farm.

Adapted from The Energy Sourcebook, Tennessee Valley Authority.

What is Electricity?

1.2 Static Electricity

Static electricity is a form of electricity that results from a gain or loss of negative charges caused by friction. Like charges repel each other and charges that are opposite (positive charge and negative charge) will attract each other.



Materials:

- Balloons
- Wool pieces
- Bar magnets
- Tissue paper
- Salt and pepper

Procedures (small group or teacher demonstration):

1. Use two bar magnets to illustrate how charges repel and attract each other depending on the arrangement of north and south ends of the magnet.

2. Rub wool over the balloon.

3. Slowly pull the wool away.

4. Rub two balloons with wool. Move the balloons near each other.

5. Rub your hair with both balloons then place the balloons near each other.

6. Move a “charged up” balloon over torn pieces of tissue paper.

7. Move a “charged up” balloon over a mixture of salt and pepper.

Graphic Organizer for Static Electricity		
Event	**Predictions**	**Observations**
One balloon with wool		
Two balloons with wool		
Rubbing balloons with hair		
Balloon with pieces of paper		
Balloon with salt and pepper		

What is Electricity?

1.2 Static Electricity

Discussion:

Read the description of electricity and try to explain what was happening in your experiment with balloons, wool, paper and salt and pepper.

Electricity is the movement of electrons (negatively charged particles that are part of every atom). Atoms are the building blocks of all matter. Atoms are made up of neutrons, protons and electrons. Electrons move in energy orbits around the centers of atoms. Electrons may be bumped from one atom to another. Electrons that move from atom to atom, carry a negative charge. Batteries, generators, thunderstorms and electric eels are some examples of things that make electrons move. Movement of electrons through thunderstorms and electric eels cannot be controlled and is of no practical value. Movement of electrons through batteries and generators can be controlled and is of great value as a source of energy.

Energy is the capacity to do work. When a chair is pushed, kinetic energy is the form of energy involved. Blowing a pinwheel or turning a waterwheel with running water is kinetic energy transformed into mechanical energy. It also can be changed to heat, light and mechanical energy. Electricity provides the power to heat, cool and entertain us. Electricity is generated in power plants from fossil fuels (coal, gas, oil), water-power or nuclear reaction.

What is Electricity?

1.3 Turbine Generators in Power Plants

Read the story of the turbine generator. Use this information to help you complete "Making a Turbine Generator".

The Turbine Generator

Electricity is our most convenient form of energy. We use it for almost every imaginable task. (Just try to imagine a modern world without electricity.) Yet there is no natural source of usable electric current. Over many years of research, people have developed ways to produce usable electric current.

The process of producing electricity is called **generation**; the machine we use to do it is a generator. A **generator** converts the energy available from some energy resource into electrical energy. A generator does not create electrical energy; it merely changes energy from some other form into electricity. (Remember that energy cannot be created or destroyed).

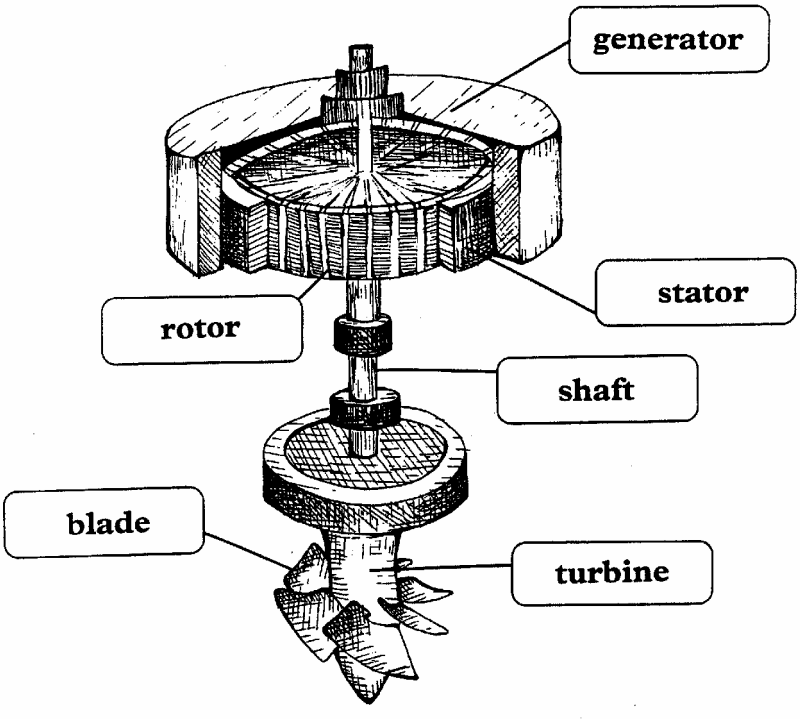
There are a number of methods used to generate electricity. One is the energy of falling water. Another is steam, produced with heat from burning a fossil fuel or from containing and controlling a nuclear chain reaction. We also use methods that involve solar and wind energy. Utility companies produce the huge amount of electricity demanded by modern societies with generators powered by falling water or steam. The three kinds of power plants common today in Maryland are hydroelectric plants (usually located in dams built for that purpose), fossil fuel-burning plants and nuclear plants.

In 1831, Michael Faraday, a British scientist, discovered that an electrical current is produced when a magnet is turned inside a coil of wires. Faraday's invention, which turned by hand, was the first electrical generator. Although much larger and more efficient generators have been developed, they still work on the same principle.

The two largest parts of the generator are the **stator** and the **rotor**. The stator is a stationary ring wrapped with wire. As the magnetized rotor spins, it produces an electrical current in the stator coils, which can be collected and distributed to wherever it is needed.

Connected to the central **shaft** of the rotor is a device called a **turbine**. It has a series of specially designed blades. When water or steam is jetted against the blades, the turbine shaft (which connects the turbine to the generator) turns and spins the generator rotor.

Each of the conventional power plants uses a combination of turbines and generators to generate electricity.



What is Electricity?

1.4 Making a Generator

Over the years we have learned that spinning magnets inside a coil of wire make electricity. In this activity, you will make a simple generator to illustrate the principle of producing electricity.

Materials:

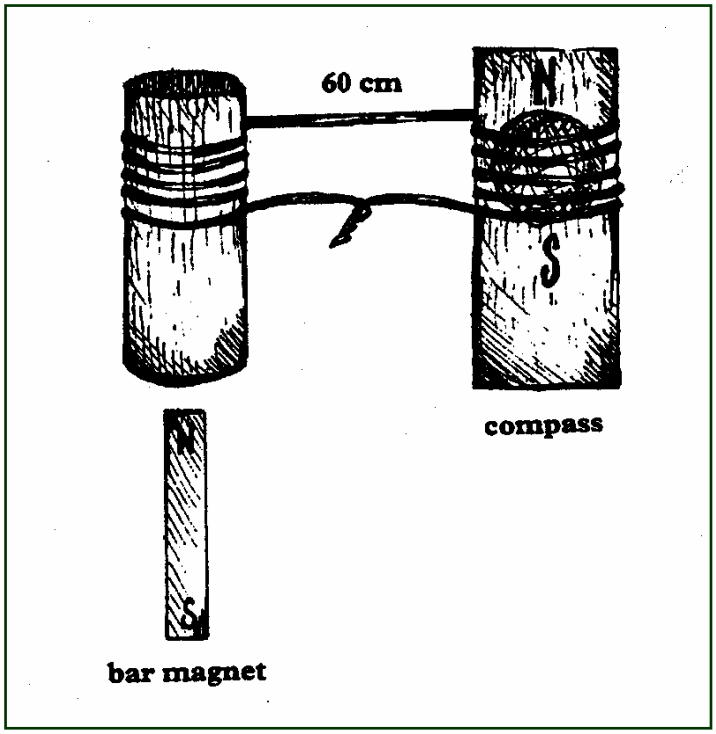
- Transparent tape (optional)
- 4 m insulated copper wire (20 gauge)
- Wire stripper/cutter
- Cardboard toilet paper tube
- 1 bar magnet
- 1 compass

Procedures:

1. Remove about 2 centimeters of insulation from each end of wire.

2. Wrap one end of the wire around the compass 5 times as shown. *Caution:* Ends of wire are sharp.

3. Extend the remainder of the wire beyond the compass and wind it around the cardboard tube 5 times. The bar magnet will pass through these coils.



4. Run the remainder of the wire back to the compass. If desired, secure the wire to the compass with transparent tape.

5. Position the compass so that the needle is directly underneath the wire wrapped around the compass. (You should be able to see the needle.)

Student Page

6. Have one member of the group pass the magnet back and forth through the end of the toilet paper tube. Keep the compass as far away as possible from the magnet (more than half a meter away); you do not want the magnet itself to cause the needle of the compass to be deflected.

7. Have one or two group members watch the compass closely. Have them observe and record what happens:

_____

_____

8. Change the direction of the magnet by inserting it from the oppose end of the tube. Observe and record what happens:

_____

_____

9. Turn the magnet around (inserting the other pole first). Observe and record what happens:

_____

_____

Discussion:

Make a conclusion about the relationship between wire coil and a moving object.

What is Electricity?

1.5 Making a Turbine

In order to generate electricity, something must be able to capture energy from another source to create motion for the bar magnet and wire coil in the generator. Follow these instructions to make a simple turbine (save the turbine for a later experiment).

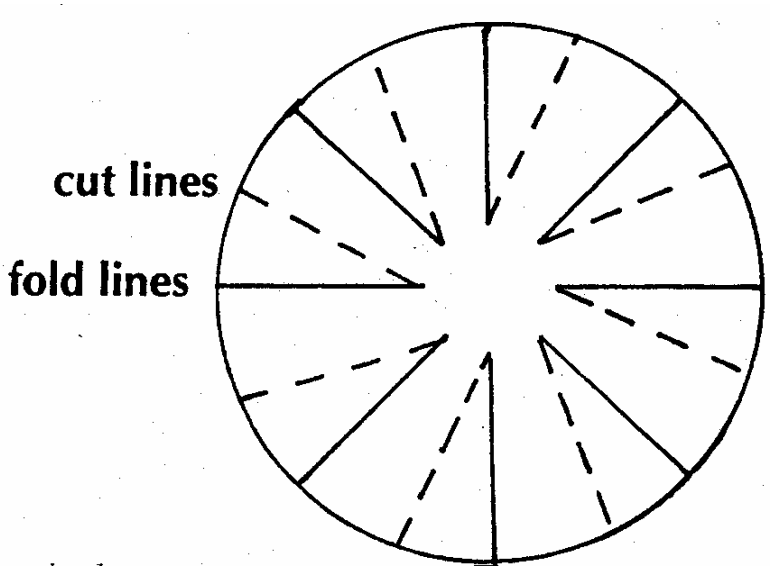
Materials:

- 1 aluminum pie plate
- New pencil with eraser
- Scissors
- Metric ruler
- Thumbtack

Procedures:

1. From the aluminum pan (pie plate), cut a circle about 12-13 cm in diameter. *Be careful in handling the aluminum due to sharp edges.*

2. Divide the circle into halves, then fourths and then eights (making the divisions by drawing your pencil down the straight edge of the ruler). As shown by the diagram at right, cut the circle into eight blades by cutting along the eight divisions to within 2 cm of the center. *Do not cut all the way to the center.*

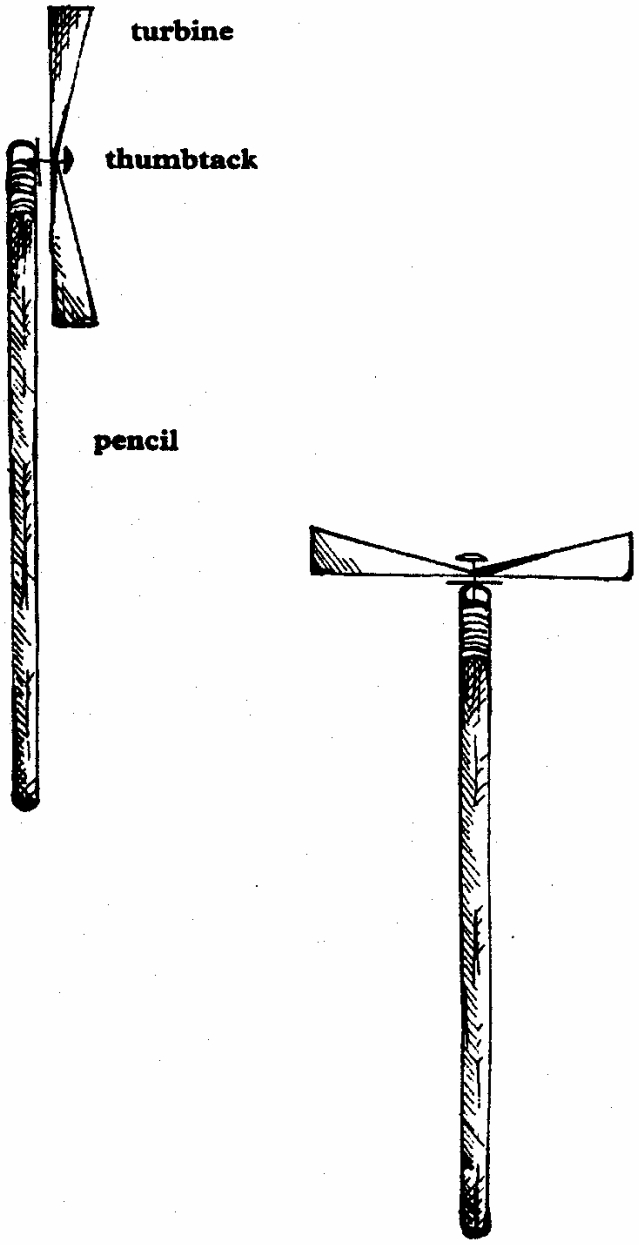


3. Fold up on side of each of the eight blades, making approximately a 90º angle.

4. With a thumbtack, punch a hole though the middle of the circle and wiggle it around so that it fits loosely on the tack.

5. Cut a 1 cm circle from the leftover aluminum and use the thumbtack to poke a hole in the center of it. Wiggle it so that it fits loosely. This will be similar to a "washer" (used with a nut and bolt).

6. Insert the tack through the turbine and the washer into the pencil's eraser (either the end or the side).



" Making a Generator" and 'Making a Turbine" are adapted from The Energy Sourcebook, Tennessee Valley Authority.

What is Electricity?

1.5 Making a Turbine

Discussion:

1. Holding the end of the pencil, blow on the turbine's blades. Describe what happens.

2. Place the turbine under a faucet. Slowly turn on the water. Describe what happens.

3. List at least two sources that could provide energy to a turbine.

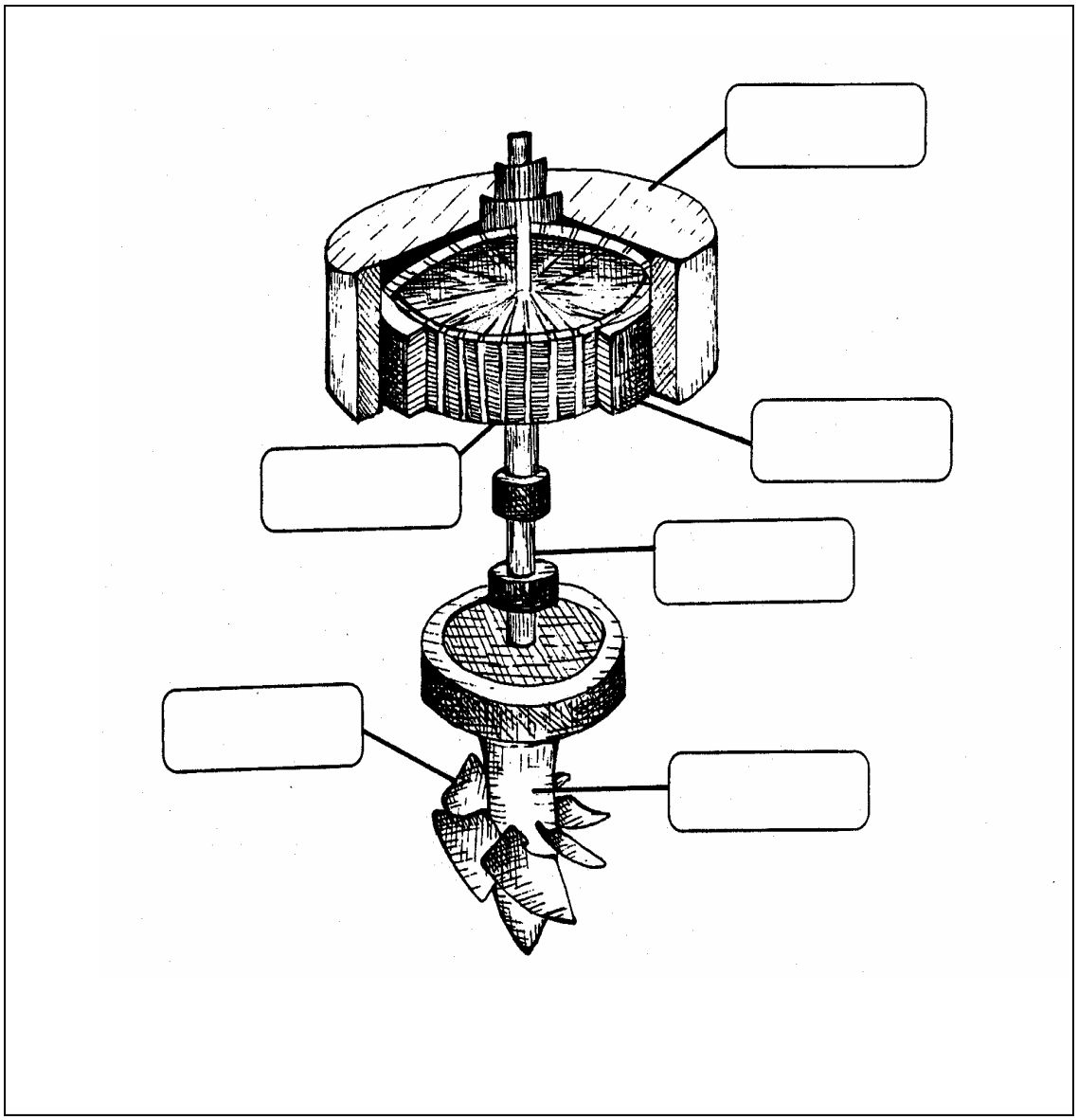
4. Predict what sources power plants use to turn turbines.

What is Electricity?

1.6 Making Electricity with a Turbine Engine

Activity A: Turbine-Generator Diagram

Use the information from the story and the two labs to label the sketch.



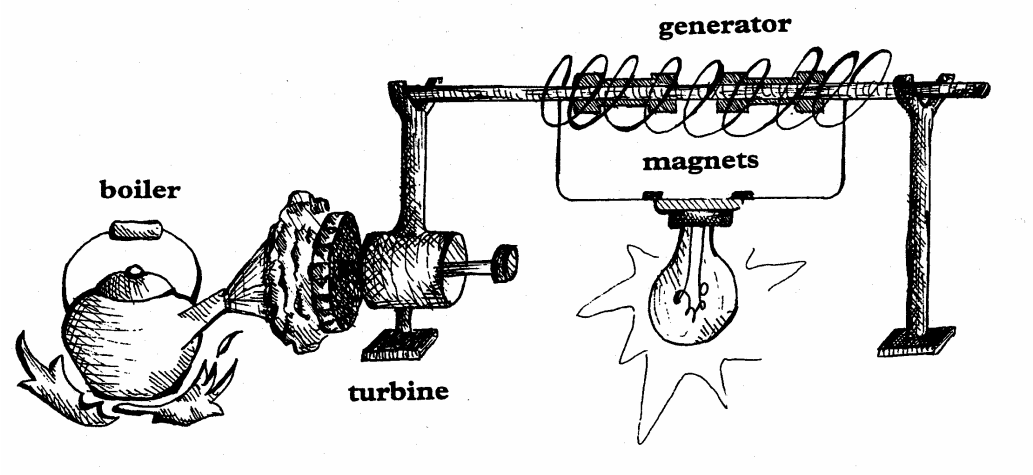
Term	Definition
Generator	A device that converts mechanical energy to electrical energy.
Blade	A metal fin extending from the turbine's shaft; force exerted on the blades causes the turbine to rotate.
Rotor	The rotating core of a generator in which electric current passing through the coils of wire produces a magnetic field.
Stator	The stationary part of a generator in which an electric current is caused by a rotating magnetic field.
Turbine	A machine in which a moving fluid (such as water or steam) pushes against blades attached to a shaft, causing the whole assembly to turn.
Shaft	Connects the turbine to the generator.
Energy Resource	Resources such as water, wind, solar energy, steam from nuclear energy or burning fossil fuels (that turn the turbine) used to generate electricity.

What is Electricity?

1.6 Making Electricity with a Turbine Engine

Activity B: How to Make Electricity

Summarize the process of generating electricity by observing the sketch and comparing the statements using the words provided.



electricity	generator	magnets	watts	steam
wire	light bulb	fossil fuels	faraday	turbine

1. A _____ causes motion to turn magnets in the generator.

2. To keep the turbine blades spinning, an energy source such as _____produced from burning _____is needed.

3. _____are important in making electricity.

4. A _____is a machine that makes electricity.

5. When a magnet is moved through coils of wire, _____is made.

6. A generator has magnets and coils of_____.

7. Wires conduct electricity ready to use such as lighting _____.